Certificate Transparency workshop

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This workshop is...

- Oriented towards CAs wanting to support CA using precertificates.
- Probably redundant if you have implemented CT-related functionality.
- Based entirely (and solely) on RFC6962.
Agenda

- Current status of CT deployment.
- Data structures used by CT.
- Submit certificates to logs.
- Generating Precertificates, certs with SCTs.
- Overview of existing code and test data.
- Getting further involved with CT.
CT Deployment - current status

- 6 Logs in operation, recognized by Chrome.
  - Operators: Certly, Digicert, Izenpe, Google (3)
- CT support required by Chrome for EV certs.
- Open-source code implementing RFC6962
  - Including production-quality log server ("super duper")
- RFC6962-bis in progress (standards-track).
What does “CT Support” mean?

Signed Certificate Timestamps (SCTs) must be presented in SSL connections.

Number varies depending on delivery method.
Methods for delivering SCTs

- Embedded in the certificate.
  - Clients have to strip out!
- During the TLS handshake
- Embedded in stapled OCSP responses.

While embedded SCTs are the focus today, the other methods are more recommended.
What’s Signed Certificate Timestamp

- Cryptographically-signed promise from a CT log to incorporate a certificate into the tree.
- Returned upon certificate chain submission.
- Contains log ID, timestamp, signature.
- Signature is over timestamp combined with EE cert.
Signed Certificate Timestamp (SCT)

{"sct_version":0,
"id":"pLkJkLQYWBSHuxOizGdwCjw1mAT5G9+443fNDsgN3BA",
"timestamp":1365427532443,
"extensions":",
"signature":"BAMARzBFAiEAd6Jf2A+WQsaoNfE12wvax6QYCeV96RPVL/aXkYBI/wCIGWrUBzj269JvVY9HJ/wrHYSC8EfZaRBlmPNi4p8d6SM"}
Binary encoding of SCTs

- The encoding used for delivering SCTs to clients.
- Based on TLS encoding (RFC5245 section 4).
Structure definition

```c
struct {
    Version sct_version;
    LogID id;
    uint64 timestamp;
    CtExtensions extensions;
    digitally-signed struct { ... } signed_entry;
} SignedCertificateTimestamp;
```
Structure definition

enum { v1(0), (255) } Version;

struct {
    opaque key_id[32];
} LogID;

opaque CtExtensions<0..2^16-1>;
Binary-encoded example

'00a4b90990b418581487bb13a2cc67700a3c359804f91bdfb8e377cd0ec80ddc100000013de9d2b29b0000040300403047304502210089de897f603e590b1aa0d7c4236c2f697e90602795f7a469215fda5e460123fc022065ab501ce3dbaf49bd563d1c9ff0ac76120bc11f65a44122b3cd8b89fc77a48c'
Example (con’d)

- Version and timestamp are fixed-size numbers (red).
- LogID is fixed-length opaque strings (blue).
- CtExtensions is variable-length opaque string (in black).
- Signature is hash alg id and sig alg id (fixed-size numbers), then var-length opaque
Submitting a certificate

POST https://<log server>/ct/v1/add-chain
Input encoded in JSON, containing:

chain:

- Array of base64-encoded certificates (in DER form).
- Starting with the end-entity certificate.
- Ending with root cert or a cert chaining to it.
Precertificate - Creation

1. Create TBSCertificate as usual
2. Add poison extension
3. Sign
4. Submit using add-pre-chain
5. Encode collected SCTs to SCTList
6. Add SCTList to TBSCertificate
7. Sign
Poison extension

- Critical X.509 extension
- OID 1.3.6.1.4.1.11129.2.4.3
- extnValue: ASN.1 NULL data encoded in OCTET STRING.

How it looks like in openssl:
1.3.6.1.4.1.11129.2.4.3: critical
Precertificate - submission

Same as X.509 certificate submission, using add-pre-chain
Embedding SCTs in Precertificates

opaque SerializedSCT<1..2^16-1>;
struct {
    SerializedSCT sct_list <1..2^16-1>;
} SignedCertificateTimestampList;
Encode as OCTET STRING and add extension with OID 1.3.6.1.4.1.11129.2.4.2.
Validating SCTs - signed data

digitally-signed struct {
    Version sct_version;
    SignatureType signature_type = certificate_timestamp;
    uint64 timestamp;
    LogEntryType entry_type;
    select(entry_type) {
        case x509_entry: ASN.1Cert;
        case precert_entry: PreCert;
    } signed_entry;
Validating SCTs - process

- Serialize all data according to TLS encoding.
- Use the log’s public key to verify the signature over the data (code).
Validating SCTs over X.509 certs

digitally-signed struct {
    Version sct_version;
    SignatureType signature_type = certificate_timestamp;
    uint64 timestamp;
    LogEntryType entry_type;
    select(entry_type) {
        case x509_entry: ASN.1Cert;
        case precert_entry: PreCert;
    } signed_entry;
Validating SCTs over X.509 certs

- Serialize all fields.
- Serialize the DER form of the X.509 certificate as variable-length opaque string.
Validating SCTs over Precertificates

digitally-signed struct {
    Version sct_version;
    SignatureType signature_type = certificate_timestamp;
    uint64 timestamp;
    LogEntryType entry_type;
    select(entry_type) {
        case x509_entry: ASN.1Cert;
        case precert_entry: PreCert;
    } signed_entry;
Validating SCTs over Precertificates

```c
struct {
    // SHA-256 hash of the issuer’s public key
    opaque issuer_key_hash[32];
    // Only the TBSCertificate part of the Precert
    TBSCertificate tbs_certificate;
} PreCert;
```

Final issuer can differ from the precert issuer!
Making sure it actually works

- **Test data**
- Testtube
- Reference implementations:
  - **Java**
  - **C++**
  - **Python**
- **CT in Chrome**
Getting further involved

- RFC6962-bis: Feedback from CAs is particularly important.
- Customer/webmaster education.
- Monitoring CT logs.
Filler: Precertificate Signing Cert

- To avoid using the same key for signing the precertificate and end-entity certificate.
- Must be certified by the certificate used for signing the final certificates.
- Identified by OID 1.3.6.1.4.1.11129.2.4.4
- Affects SCT validation.